

AGRICULTURAL EXPERIMENT STATION

Sixteenth Annual Report

OF THE

North Dakota
Agricultural Experiment
Station

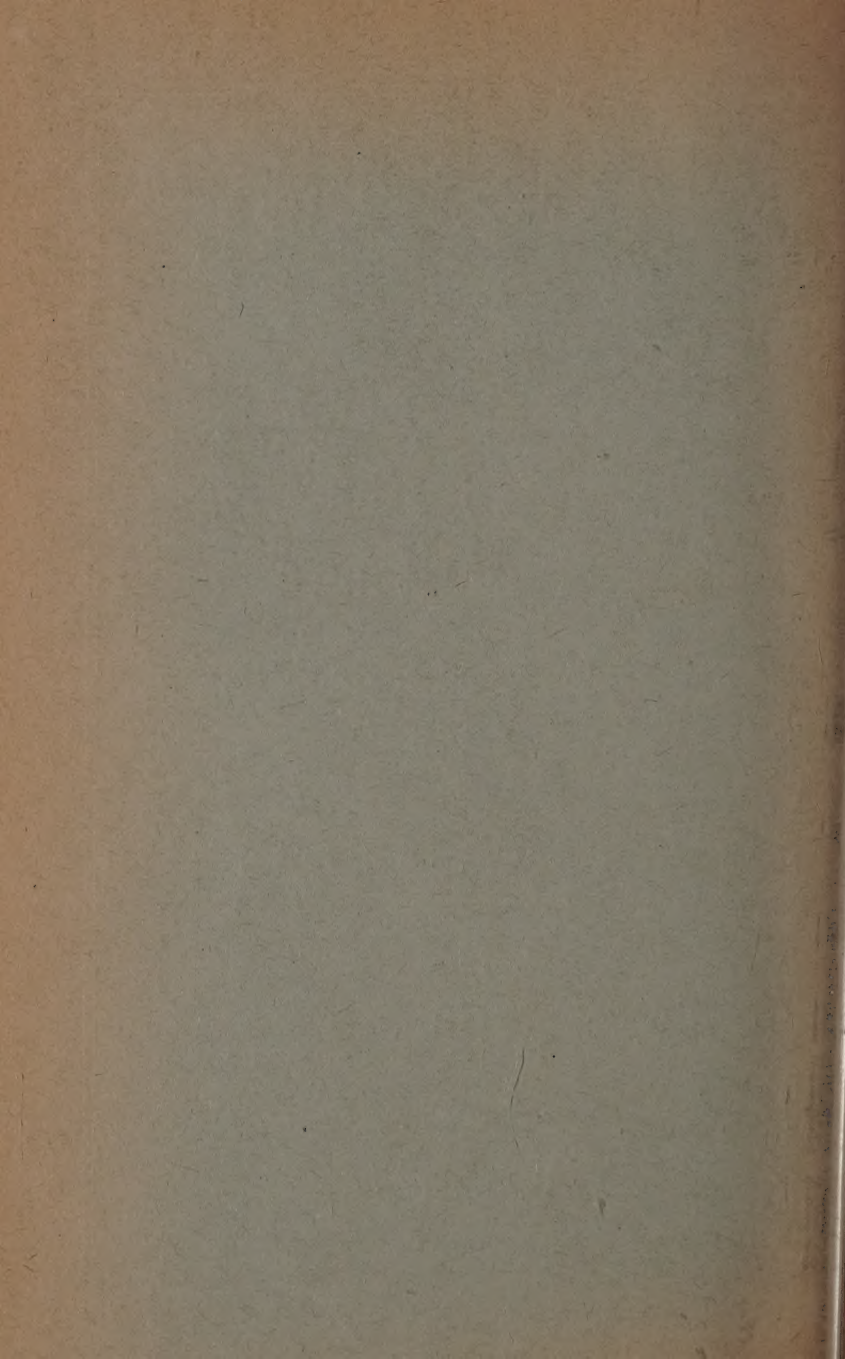
Agricultural College, North Dakota

TO

The Governor of North Dakota

1906

FARGO, N. D.
Walker Bros. & Hardy, Printers
1906





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LETTER OF TRANSMISSAL.

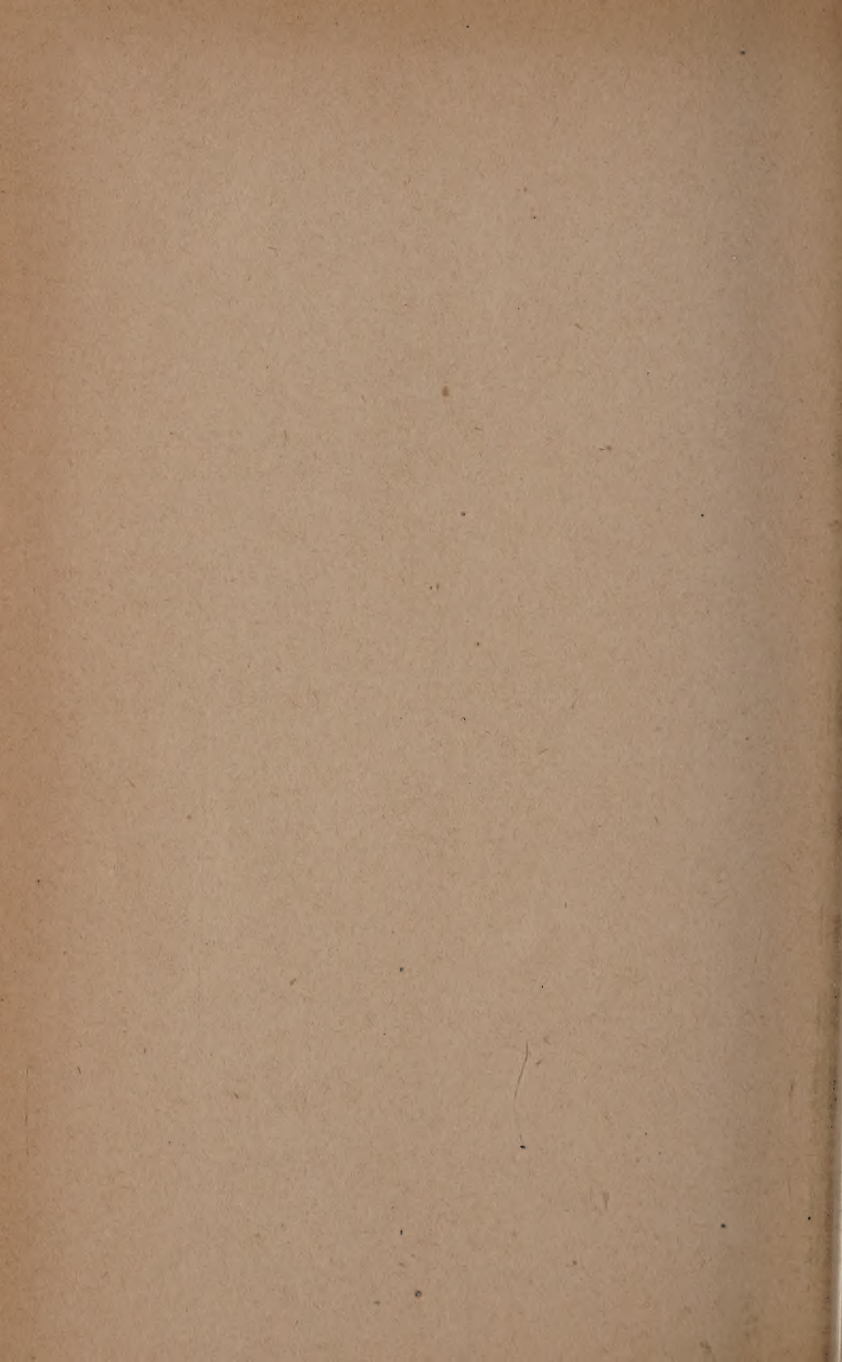
Agricultural College, N. D., February 1, 1906.

Hon. E. Y. Sarles, Governor of the State of North Dakota—

Sir: As required by Act of Congress, approved March 2, 1887, I hereby submit the Sixteenth Annual Report of the North Dakota Experiment Station for the year ending February 1, 1906, together with a financial statement of receipts and disbursements, as required by law, for the government fiscal year ending June 30th, 1905.

Very respectfully yours,

B. N. STONE,
President Board of Trustees.



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STATION STAFF.

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C. B. WALDRON, B.S.	Horticulturist
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O. O. CHURCHILL, B.S.	Assistant in Plant Breeding
F. J. PRITCHARD, B.S.	Assistant in Plant Pathology
C. D. HOLLEY, M.S.	Assistant Chemist
W. B. RICHARDS, B.S.A.	Assistant in Animal Husbandry
NICOLAS GREST	Farm Foreman
L. R. WALDRON, M.A.	Superintendent Dickinson Sub-Station
O. A. THOMPSON, B.S.	Superintendent Edgeley Sub-Station



REPORT

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

Gentlemen: I have the honor to submit to you the sixteenth annual report of the North Dakota Government Experiment Station.

The following bulletins were published during the year:

No. 64—Root Systems of Field Crops.

No. 65—Experiments in Clover Growing.

Trials with Alfalfa.

No. 66—Waters of North Dakota.

No. 67—Paints and Paint Products.

"SOO" LINE SPECIAL BULLETINS.

The following bulletins were prepared and distributed along the line of the "Soo" railroad.

No. 1—Selecting Seed Grain.

No. 2—Grading Seed Grain.

No. 3—Testing the Germination Power of Seed Grain.

No. 4—Seed Treatment to Prevent Diseases in Field Crops.

The Use of Formaldehyde.

No. 5—Seeding Grain.

THE EDGELEY SUB-EXPERIMENT STATION.

Supt. O. A. Thompson made a good record for 1905. Aside from building a new and commodious residence on the station farm, he conducted many interesting and valuable experiments. The season was favorable for experimentation along all agricultural and horticultural lines and his report will be read with profit.

Mr. Thompson is peculiarly fitted for experimental work as well as for plant breeding and is rapidly solving agricultural problems peculiar to the lighter and drier soils of the state.

DICKINSON SUB-EXPERIMENT STATION.

Since my last report the Dickinson experiment station has been established, the citizens of Dickinson and Stark County having donated a quarter section of land as provided for in the Act establishing the station.

Owing to the lateness of the season when the work was begun, but little could be accomplished in the way of field trials and culti-

vation experiments during the season of 1905, but those made were such as to promise good results for the future of that section of the state.

A fine brick residence and a commodious frame barn were erected on the station grounds and the work of experimentation will be pushed vigorously the coming season.

L. R. Waldron, formerly of the Department of Biology at the Agricultural College, was elected superintendent of this station and is in every way qualified for the position.

CO-OPERATIVE EXPERIMENTS.

The varied soil and climatic conditions of the state warrant the establishment of co-operative experiments with skillful farmers in the different counties outside of the Red River Valley. This cannot be undertaken, however, until the legislative assembly appropriates money for that purpose. The home station and the sub-stations now established at Edgeley and at Dickinson are admirably located for the purpose of working out all principles that can have a bearing upon our agriculture. To further increase the number of sub-stations would prove a waste of money and energy. To emphasize in many localities the principles that are being determined at the experiment stations, however, is very desirable. At comparatively small expense on each demonstration farm, an object lesson in improved farming can be maintained in most of the counties of the state—an object lesson that will show the advantages that may be secured from improved methods of tillage, improved seed, and proper rotation of crops, such as may be adapted for each particular locality. The work of the experiment stations thus can be emphasized in all parts of the state in a way that would prove helpful to every community.

TILE DRAINAGE EXPERIMENTS.

The excessive moisture greatly interfered with the crops and many of the experiments on the station farm during the past season. This condition was general throughout the Red River Valley, many sections proving so wet that mature crops could not be harvested. The necessity for a thorough system of drainage, by means of open ditches, was never more apparent. The feasibility of tile drainage, however, is problematic, but should be undertaken on a scale of sufficient magnitude to demonstrate its usefulness or impracticability. Arrangements are being perfected for co-operative work with the Division of drainage and irrigation, Department of Agriculture, to ascertain the effect of tile drainage. It is proposed to underdrain about 40 acres on the experimental grounds the coming season. This will require an expensive canal or outlet to carry the water to the Red River, the expense of which the Department of Agriculture has promised to share with the Experiment Station. We hope to get the work well under way during the summer of 1906.

SEED TRAIN SPECIAL.

The seed train special operated last spring on the "Soo" railroad was productive of much interest among the farmers living tributary to that line. The Farmers' institute bore the expenses, aside from cost of train and equipment which the "Soo" road generously furnished. The Experiment Station staff provided the speakers, and also the literature for gratuitous distribution among farmers. It is proposed to repeat the experiment the coming spring, not only on the "Soo" railroad, but on the Northern Pacific and Great Northern lines.

The purpose of the seed train specials is to meet the largest number of farmers possible, within a limited time, and explain to them the advantages of selecting choice, clean seed for sowing, best method of preparing seed bed for grain, advantages of crop rotation, use of formaldehyde as a preventative of smut, etc., etc.

Too much credit cannot be given to Professor E. E. Kaufman, Secretary of Farmers' Institute, for arranging for and conducting these specials.

IMPROVEMENTS.

The following improvements were made during the summer of 1905:

POULTRY HOUSE.—Owing to the loss of the station poultry house by fire during the winter of 1904, it became necessary to erect a new one, which was completed last summer. The new building is 18x70 feet with 8 foot posts. It has nine separate apartments for fowls, six of which are 8x13 feet, and three somewhat smaller. An alley way of 3 feet 9 inches wide extends the full length of the building. A feed and incubator room 9x13 feet is provided. The walls are packed with a three-inch layer of shavings. The ceiling is covered with a six-inch layer of shavings. The floor is solid cement covered with a bed of sand.

SWINE BARN.—The old combination swine and sheep barn proving inadequate, it became necessary to erect a separate building for the swine. A new barn was erected last summer, 64 feet long by 26 feet wide, with 14 foot posts. It contains twelve pens, six on each side, with a five-foot alley way running the entire length of the barn between the two rows of pens. Three of the pens on each side are 8x10 feet, two are 10x6½ feet, and one 10x12 feet. The building is provided with an office room 10x12 feet and a feed room 12½x16½ feet. A scale room is also provided 6½x10 feet in size.

The floor is made of concrete supported on sills with inch flooring with the exception of a space 4½ feet wide at the rear of the pens. This portion of the floor is made of plank, so as to provide a comfortable place for pigs to lie on.

PLANT HOUSE:—There has been finished as an addition or annex to the botanical laboratories, a small, but very perfect, green house. The house is situated 16 feet south of Science Hall, and is connected with the botanical laboratories by a glass covered passageway 16 feet long by 8 feet wide.

The floor space consists of a central house, 24x24 feet, with two wings each 17x17 feet. The floors are constructed of heavy concrete and cement. The side walls are of brick and concrete with a smooth finish of cement on the interior. The masonry stands three feet above the concrete floors surmounted by high glass sides. The roof of the central house is of cottage construction, topped by a square glass ventilation shaft, 6x6 feet. The wings are constructed with gable roofs. All wood work is of the best southern cypress; and the soil benches or beds are of hollow, porous tiles resting upon a solid metal framework.

There are also four large concrete aquaria for the culture or growth of aquatic plants and animals.

CHEMICAL LABORATORY.—During the past year there has been built a chemical laboratory, the main part being 76 feet by 50 feet and three stories in height, with two wings each 50 feet by 30 feet, each two stories in height; and attached to this building is a small green house, 16 feet by 20 feet, for conducting experiments in plant nutrition and for the use of students in farm chemistry.

The building contains 29 rooms and is especially designed and adapted for both the work of the Experiment Station and the College. On the first floor are two laboratories for experiment station work, a small library and reading room, a food laboratory, two small laboratories for special work, store rooms, a laboratory for students in farm chemistry and domestic chemistry to accommodate thirty-two students and a laboratory in physiological chemistry.

On the second floor are located the office and private laboratory of the head of the Department, a large quantitative laboratory to accommodate thirty-six students, a qualitative laboratory sufficient to accommodate thirty-six students or, by working in alternate periods, seventy-two, and three rooms devoted to pharmacy, of sufficient sizes to accommodate a class of thirty students.

On the third floor is located a large lecture room, an auditorium with sufficient capacity to accommodate 150 students. This room is fitted up with apparatus for demonstrating purposes. There is also a good chemical museum and a large class room. The building also contains several store and smaller rooms and a good dark room for photographic purposes. In the tower of the building is located the instruments for meteorological work.

The building was constructed to cost \$48,000 and to this there was added \$2,500, expended for fixtures and apparatus. The exterior of the building is of Twin City pressed brick, trimmed with

Kettle River sandstone. The building is finished in yellow birch, natural finish, with the exception of one wing, which is finished with yellow pine.

J. H. WORST,
Director.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

Sir: I herewith present my sixteenth annual report as chemist of the North Dakota Government Agricultural Experiment Station for the calendar year 1905.

During the past year the work in this Department has covered an unusually wide range of subjects. Among the subjects which have been under investigation may be mentioned the following: Analyses of waters for citizens of the State, meteorological studies, analyses of certain typical soils, investigation of human milks and the determination of the strength of formaldehyde, for which purpose 199 samples were tested. There have also been made tests of oils and many miscellaneous products which have been submitted to the laboratory.

In addition to the above we have, during the past year, under the food and drug laws of this state, examined over 3,000 samples in order to determine to what extent adulteration or fraud is practiced in the preparation and labelling of these common products.

The amount of correspondence during the past year is exceptionally large. This will be indicated from the fact that there were written 2,822 letters, and this not counting duplicates or the large number of circular letters sent out. During the year there were sent out about 2,000 postal card notices. There have also been prepared by this Department during the year four bulletins.

Special Bulletin No. 2, "A warning Regarding the Use of Chemical Preservatives in Meats," seven pages.

Special Bulletin No. 3, containing a compilation of the pure food law, pure drug law, formaldehyde law, Paris green law, paint law and rulings and discussions dealing with the same, 22 pages.

Bulletin No. 66, "Waters of North Dakota," includes the analyses of 160 samples of drinking water, besides several mineral analyses and a discussion of the subject from the standpoint of North Dakota waters, fifteen pages.

Bulletin No. 67, "Paints and Paint Products," deals with a discussion of materials entering into the composition of paints and gives the results of analyses of a large number of mixed paints found upon the market in this state, thirty-two pages.

During the year there has been built and equipped a new chemical laboratory, the main portion being three stories, with two wings

each two stories in height. This building is especially adapted to the work of the Experiment Station and gives us facilities which in the future will enable us to conduct our work with a greater degree of satisfaction. Looking after the details of this building during the process of construction has required considerable of my time.

SUMMARIES OF TEMPERATURES, RAINFALL AND SUNSHINE.

Meteorological records at this Station have been maintained since the opening of the Station sixteen years ago. The data for each year has been published in the preceding annual reports and in the report for 1902 was given a general summary for the preceding ten years for various points in this state. For the present year we have the following data:

TEMPERATURE AND RAINFALL, 1905.

Month.	Mean.	Max.	Min.	Rainfall, In.
January	0.3	35.	—30	0.8
February	7.0	59.	—34	trace
March	31.2	68.	—11	.51
April	39.5	77.	12.	1.28
May	51.8	81.	30	5.77
June	61.1	85.	40	5.00
July	65.8	92.	42	5.17
August	68.	93.	44	6.82
September	61.4	89.	37	3.47
October	41.2	85.	9	1.18
November	31.7	64.	—27	.71
December	14.77	38.	—18	.05
Average and Total.	39.43	72.16	7.83	30.76

While the mean temperature for January was slightly lower than that for the same month of 1904, the mean for February was 10.1° higher than for the preceding year. The mean temperature for 1905 was 2.39° warmer than for 1904, while the maximum temperatures averaged 2.40° warmer. The mean minimum temperature is identical with that of 1904.

The rainfall for 1905 has been the highest for any year since our record began at the station, or a total of 30.76 inches as compared with 21.62 inches, the mean averaged for the past fourteen years. One of the marked differences between the two years is that for the month of August, where in 1904 the total rainfall was .65 inches and for 1905 for the same month it was 6.82 inches, while that for September was practically the same as for 1904. This makes the fall an exceptionally wet one for harvest work.

The annual rainfall since 1892 is shown in the following:

	1892	1893	1894	1895	1896	1897	1898
Rainfall—_inches	20.73	16.17	18.72	16.05	21.77	22.50	16.36
	1899	1900	1901	1902	1903	1904	1905
Rainfall—_inches	21.20	25.54	25.68	23.16	23.81	20.26	30.76

This gives an average rainfall of 21.62 inches for the past fourteen years with a minimum of 16.05 in 1895 and a maximum of 30.76 in 1905.

MONTHLY RECORD OF SUNSHINE.

The record of the sunshine is taken by means of a Friez Photographic Recorder, but no correction has been made in the record for early morning and evening sunshine, which amounts to approximately twelve per cent more than the recorded sunshine.

Unfortunately our apparatus was tampered with during the months of February and October, thus destroying the records for these two months.

Total Hours		Hours daily mean		Percentage
Month	Possible	Recorded	Possible	Possible Sunshine
January	279.1	124.7	9.00	46.13
February . . . . .	.....	.....	.....	.....
March	469.00	122.10	11.90	33.18
April	407.3	188.9	13.57	46.34
May	456.3	217.6	14.7	46.70
June	475.00	187.00	15.8	40.00
July	480.2	310.1	15.4	64.39
August	441.8	231.9	14.2	52.12
September	378.3	215.8	12.6	57.19
October . . . . .	.....	.....	.....	.....
November	281.6	98.1	9.38	34.64
December	267.1	104.8	8.61	38.51
Mean	38.35	18.01	12.51	45.92

The total of the means as given by the preceding Table are for the ten months' record and, therefore, not wholly comparable with the yearly record as given in previous reports.

EVAPORATION FROM A WATER SURFACE.

For the preceding three years we have published a record showing the daily evaporation of water from a water surface for the principal growing months. Distilled water was employed and the experiment was conducted as outlined on page 20. of the Thirteenth Annual Report of this Station.

Date	May	June	July	August	Sept.
1	.2	.3	.1	.1	.23
2	.1	.42	.1	.11	.00
3		.2	.16		.2
4		.37	.03	.2	.1
5	.11	.3	.12	.2	.1
6			.12	.16	
7	.22	.1	.34	.93	.1
8	.2	.3	.1	.2	
9		.1	.11	.1	.1
10			.2	.1	.1
11		.2	.3		.1
12	.12	.32	.3	.05	.1
13	.2	.45	.2	1.05	.13
14	.01	.26	.3	.54	.1
15		.12	.86	.12	.09
16	.2	.05	.52	.64	
17	.2	.25	.26	.49	.09
18	.2	.01	.2	.11	.1
19	.2	.2	.2	.1	.1
20	.8	.29	.1	.1	.1
21	.25	.21	.33		.1
22	.2	.15	.2	.34	.1
23	.16	.17	.2		.2
24	.22	.04	.2	.1	.1
25	.2	.24	.1	.1	.09
26		.01	.26		.1
27	.3		.13	.2	.1
28	.2	.24	.1	.2	.1
29	.2	.1	.11	.2	.3
30	.3	.2	.34	.07	.25
31	.2		.1		
Totals.....	4.37	5.60	6.67	6.51	3.28
Mean.....	.182	.186	.215	.21	.109

The total amount of water evaporated for the five months, May to September inclusive, from a water surface, gives an average of 5.286 inches per month and a daily average of .179 inches. This is considerable less than for the preceding years. The summary for the past four years is shown by months in the following table.

INCHES OF EVAPORATION.

Month	1902	1903	1904	1905
May	6.48	4.30	6.40	4.37
June	5.75	8.69	5.40	5.60
July	4.77	13.26	8.05	6.67
August	6.62	12.07	8.30	6.51
September	4.50	3.55	2.29	3.28
Total	28.12	41.87	30.44	26.43

For the four seasons there is shown a wide range of differences. The data, when examined in connection with other meteorological data, furnish much instructive information. The rainfall for the same period by months was as follows:

INCHES OF RAINFALL.

Month	1902	1903	1904	1905
May	4.25	2.78	1.47	5.77
June	3.97	.56	3.83	5.00
July	2.54	2.62	2.83	5.17
August	2.95	4.61	.69	6.82
September	1.61	5.61	3.49	3.47
Total	14.32	16.18	12.30	26.23

In 1902, the evaporation was 1.96 times the evaporation of rain-fall for the same period. In 1903 it was 2.58 times as great and in 1904 it was 2.47 times as great, while for 1905 the rainfall as compared to the evaporation was as 1 to 1.003. The rain-fall was practically equivalent to the total evaporation.

PRUSSIAN STOCK FOOD.

Mr. Z. W. Rogers, St. Thomas, N. D., sent in a sample of Prussian Stock Food produced by the Prussian Medicine Co., St. Paul, with the request that we analyze the same. The result of our examination for the water free substance was as follows:

ANALYSIS OF STOCK FOOD.

	Per Cent
Ash	16.01
Fat	7.99
Crude fiber	8.33
Proteid N x 6.25	16.38
Nitrogen free extract	51.29
	100.00

KENTUCKY HORSE FOOD.

A sample of co-called stock food called Kentucky Horse Food, Kentucky Horse Food Company, was sent to the laboratory with the request for examination. Our examination showed the following composition for the dry substance:

	Per Cent.
Ash	23.30
Fat	4.15
Crude fiber	10.97
Proteids Nx6.25.....	12.69
Nitrogen free extract	48.89
	100.00

STOCK FOODS.

Three samples of stock foods were submitted for analysis by D. M. Young, Youngstown, N. D. All these samples were said to have been produced by the Security Stock Food Company, Minneapolis, Minn. No. 1 was called Calf Food; No. 2, Worm Powder; No. 3, Stock Food. Our analysis showed them to have the following composition:

	Calf Food.	Worm Powder.	Stock Food.
Water	4.81	4.15	4.04
Ash	12.36	50.49	26.57
Fat	6.98	3.68	9.98
Crude Fibre	6.80	3.86	6.85
Proteids	15.63	6.13	11.38
Nitrogen Free Extract...	53.42	31.69	41.18
	100.00	100.00	100.00

An examination of the mineral or ash constituents found in the Worm Powder showed the presence of 38.78 per cent of alkaline chlorids, mainly salt and about five per cent of Glauber's salts.

GROUND LINSEED CAKE.

A sample of ground linseed cake produced by the Minnesota Linseed Oil Co., Minneapolis, Minn., and guaranteed to contain:

Proteids	34% to 38%
Fat	5% to 8%

was submitted for analysis. Our results for the sample were as follows:

	Per Cent
Water	9.30
Ash	5.50
Fat	4.16
Crude Fibre	6.66
Proteids Nx6,25	38.81
Nitrogen free extract	35.57
	100.00
Nitrogen	6.21

This is an exceptionally good product and while it falls somewhat short in fat in the other and more valuable constituent, proteids, it exceeds the guaranteed maximum per cent.

ROTTED MANURE.

A sample of well rotted mixed manures submitted by S. H. Taylor, Mayville, for examination was found to contain in the air dried substances as follows:

	Per Cent
Moisture	1.29
Nitrogen	2.25
Phosphoric acid, P_2O_5	1.35

A large pile of manure near a town where it had accumulated for years was sampled from two places and the same submitted for analysis. Our examination for these showed the following:

	No. 1	No. 2.
	Per Cent	Per Cent
Moisture	64.39	52.41
Ash	14.43	22.26
Volatile and organic matter	21.18	25.33
Nitrogen	.672	1.09
Phosphoric acid, P_2O_5	.64	.47
Potash, K_2O	.58	.53

SAMPLES ANALYZED.

Under the terms of the North Dakota law, Paris green, which contains less than 50 per cent of total arsenous oxide or more than 4 per cent of free or uncombined arsenous oxide shall be deemed adulterated:

Eleven samples were taken up and examined for the purpose of determining the character of the products and the results are presented in the following table:

101	Ansbacher & Co., New York.....	3.46	52.38
102	Ansbacher & Co., New York.....	7.41	54.36
103	Unknown—Bulk	1.73	45.46
104	C. T. Reynolds & Co., Chicago.....	6.17	57.32
105	Unknown—Bulk	1.98	57.32
106	Unknown—Bulk	1.48	56.34
107	Ansbacher & Co., New York.....	7.41	59.72
108	Unknown—Bulk	18.77	51.39
109	Sherwin-Williams Co.	5.93	52.18
110	Ansbacher & Co., New York.....	.98	50.01
111	Noyes Bros. & Cutler, St. Paul.....	3.70	....

An inspection of the above shows that five of the samples contained excessive amounts of free arsenous oxide ranging from 5.93 to 18.77 per cent, while one of the samples contained a total of 45.46 per cent of arsenous oxide instead of 50 per cent prescribed as a minimum. Certainly the use of Paris green like No. 108 would probably prove injurious to most foliage and it is believed that from this time on, there will be a marked improvement in the character of the product which is offered for sale in this state as manufacturers and jobbers have taken steps to see that the products which they are handling comply with the requirements of the law.

RECOMMENDATIONS AND ACKNOWLEDGMENTS.

Much of the analytical work given in these pages is that of my assistants, who have carefully performed the various duties assigned them by this Department. I desire to commend them and the efforts put forth, which have resulted in whatever of success has come to the Department during the past year.

To Mr. C. D. Holley, who has had charge of much of the analytical work and especially that pertaining to paints and paint constituents.

To Mr. C. H. Kimberly, who has had charge of the work in the examinations of extracts, drugs, etc.

To Adele Shepperd, who has had charge of water analyses and examination of stock foods and feeding stuffs.

To Mr. A. G. Nickles, who has had charge of the examination of food products and beverages, with especial reference to adulterations.

To Mr. R. E. Stallings, who has had charge of the physiological chemistry and especially to work pertaining to wheat investigations now in progress.

Respectfully submitted,

E. F. LADD,
Chemist.

DEPARTMENT OF BOTANY

To Director J. H. Worst:

Sir: I herewith transmit an outline report of the work of the Department of Botany for the year ending Dec. 31st, 1905.

The chief lines of investigation have been confined to studies upon wheat, flax, potatoes, grass and native plants. Special attention has been given to crop diseases and to the study of the development of such diseases as rust, wilt and blight with a view of fixing some principles or methods of breeding looking toward the production of disease resistant crops. In the way of added equipment, the new plant house, lately finished as an annex to the botanical laboratories, it is hoped will prove a great aid in the prosecution of necessary studies along the line of plant physiology and plant diseases.

Wheat Rust and Wheat Smut: Continued studies upon stinking smut of wheat, prosecuted at this Station year after year, have given us many opportunities for observation upon the nature of this particular fungus disease. Rust, year after year, in spite of all studies and investigations, continued to take a regular share of the harvest and, at times, locally becomes epidemic to the very point of complete crop destruction. In the case of smut, our investigations have allowed us to point out methods of treatment sufficiently simple to allow any farmer to escape the damage usually occasioned by this disease. The rusts, however, are of such general nature, spreading by the wind from field to field, that no mode of special treatment seems available.

Resistant or Immune Wheat: While conducting these special experiments upon smut, our observations leave us slight reason to doubt that it will be possible to select, grade and breed strains of wheat, which have marked powers of resistance, to each of these destructive diseases of cereal crops.

The Work of Selection: To gain the types of resistance to rust and smut, we have been working along several lines. The method is essentially to produce in the crop the greatest possible amount of disease, striving to give the crop the greatest possible rust and smut conditions, with a view of destroying all types and strains and individuals in the crop which are not able to withstand such conditions; saving the seed from those which survive and produce proper form as to yield and quality. The process is continued

year after year. We test many varieties, individual strains and cross breeds. To gain the best possible mother plants we used several methods of selecting: (1) Saving only those plants giving the best type of foliage for resistance to rust infection; (2) those giving the best type of grain; (3) those giving best type of individual plants as a whole; (4) by selecting the crop and variety which gives the best total yield or crop, and by using the ordinary methods of grading the seed of crop as a whole.

The method of putting the individuals and types to test is always the same, viz., the subjecting of the growing plants to all of those conditions most liable to produce rust and smut in the crop. We base this method of work upon the theory that "like begets like" more nearly than anything else; and we strive to put such conditions into operation as will call for the survival of the strong only; the process itself acting as the chief discarding agent to eliminate the weak and non-resistant types.

As an experiment illustrating the method, we have grown each year, for a number of years, wheat from the same parent strain of seed. Each year we have graded this seed and hand-picked it to the most most perfect form of kernels, and each season before planting, have thoroughly coated these grains with viable smut spores. It has been observed that each year the amount of smut infection possible to secure grows less and less. It was further noted in the rust year of 1904, that this crop was more resistant to rust than any other of the same type of grain seeded in the immediate neighborhood. Commencing with that crop we have started the joint experiment, recognizing that those plants which were most attacked by smut were also affected by rust. This is a peculiarity regarding rust which is quite characteristic. Any fungus disease, or any other condition which weakens the normal growth of the wheat plant, seems to make it more subject to rust.

During the season of 1905 we made 275 separate plantings of wheat upon various sized plots to study this question of resistance to rust and smut. All these tests tend to prove the principle that every variety of wheat now under common cultivation seems to possess certain type or strains of individual plants which are particularly predisposed to rust and smut, while certain other strains and individuals may be noted which show considerable power of resistance.

Forty-two tests were made to determine the effect of deep and shallow planting of shrivelled wheat from a previous rusted crop. The results: Always favorable to shallow planting, provided the grains were sufficiently covered to escape blowing. Rust attacked both deep and shallow planting with apparently the same vigor, but smut attacked the deep planting more frequently than the shallow.

Thirty-eight tests were made for the purpose of comparing the value of shrivelled grain from rusted crops, with plump or non-

shrivelled grain from the same crops. The samples of seed selected, were obtained from many different farmers throughout the state and were, aside from being shrivelled from rust, otherwise quite perfect. The grain was so graded that the shriveled sample weighed approximately forty pounds per bushel, while the plump sample would reach a standard excelling fifty pounds per bushel. The result of these tests, though the grains of both samples were given exactly the same condition as to planting, being planted in a machine which gave exactly the same depth to each grain, was markedly in favor of the heavier and plumper seed in every test. The heavy seed made the sturdiest growth from the start and maintained it to the end, giving at the time of harvest, marked excess in both straw and grain over the light-weight seed. Only one feature seemed to be in favor of the light-weight seed. It always germinated more quickly and came up a day or two earlier. This is easily explained because a small shrivelled grain of wheat absorbs water more rapidly than the perfect, heavy weight grains, becoming sufficiently wet to germinate more quickly than heavier seeds.

Fifty trials were made using the noted Farrer's Australian pedigreed seeds. These tests were made under the centgener method, each grain being planted at exactly the same depth of every other grain and the seed being planted at a rate of one grain every four inches. Some of these Australian high bred wheats have been noted rust resisters in the country in which they were developed. Many of them are of the fife type, and it was hoped that some of them might prove of rust resisting power in this region. But they showed no special merit during the years' trial. Even the noted variety Rerraf, which is considered Australia's most perfect rust resisting variety, seemed almost non-resistant, although it was fully a week earlier maturing than some of our native wheats.

Ten experiments were made in treating seed wheat for the prevention of stinking smut, with the result that none of the methods were found to equal the methods of treatment with formaldehyde, previously recommended by this department.

Several experiments were made to determine the best method of procuring the perfect grains of wheat from a rusted sample of wheat. A number of tests were made, using salt solutions, but it was found that ordinary solutions of salt could not be made strong enough to sort out wheat which weighed more than sixty pounds to the bushel without causing considerable injury to the powers of germination. A small wind power, vertical blast grader, was devised which allowed the grain to be graded vertically through a heavy, constant blast of air. It was found that this method would grade wheat in such manner that the heaviest grains were selected, whether they were small grains or large grains. In this manner a bushel of very much shrivelled fife wheat from the rusted crop of 1904, was graded so that one quart of the best plump seed was removed from a bushel. This sample of seed wheat so selected, showed remarkable

powers of resistance to rust in 1905 and gave a most perfect growth of wheat as compared, with all other methods of selecting the supposed perfect seeds.

During the season of 1904-5, it was learned in this laboratory that quite a large percentage of the grains of wheat found in the shrivelled sample of either durum or fife wheat might be internally infected with rust, *Puccinia graminis*, even Uredo and Teleuto-spores being produced under the bran layer in close proximity with the germ. It was found that these wheat grains retained their viability. These facts are new to the history of wheat investigation. Numerous such internally infected grains were selected for growth and planted under the centgener method of planting, with the result that we were unable to decide whether such wheat could become infected from the internally rusted grain. This line of investigation has been continued with no definite results.

Twenty-six plantings of shrivelled wheat from a rusted crop were planted at different depths for the special purpose of noting the effect upon the growth of rust, with negative results.

Many plantings of wheat were made at different dates during the spring, using always the same method, for the purpose of observing the progress of rust development. Result: Our observations teach that the rust known as the lesser orange leaf rust, *Puccinia rubigovera*, sometimes called by the farmers "red rust," may appear upon the wheat immediately after the first leaf, at least by the time the second or third leaf appears. It is not common, however, to see the stem rust, *Puccinia graminis*, upon young wheat, even though it is generally abundant upon older wheat in the immediate neighborhood. It seems as though the general outbreak of this species of rust does not usually occur until a certain stage of crop development has been attained. Usually the pustules begin to appear abundant just preceding the blossom stage. It is a common thing that there may be a marked variation in the damage produced by rust, according to the date of planting, but this is a matter which cannot be settled for any given season. The amount of rust upon a given planting seems to depend upon some particular climatic variation, upon the days when the stage of wheat development and development of rust coincide.

Over five hundred individually selected plants were made from the crop of experimental planting for the season of 1905. These are to be used in our experimental planting in 1906, only the best plants being finally selected. This is the way that special strains or varieties are produced and illustrates the fact that farmers may greatly improve their own types of seed by careful methods of grading and by refraining from persistently changing or discarding the type of seed with which they are working. The results of our numerous investigations, extending over a number of years, have been compiled and are now being published in bulletin form.

Rust Infection Experiments: Numerous experiments were conducted for the purpose of determining the relationship existing between the different types of rust upon cereal grains, and upon the wild plants, grasses and weeds which are liable to be associated with or near the crop. Many quite interesting results were obtained, but they will be more properly reported upon in connection with bulletins especially concerned with the work. It is enough at this time to indicate that this is a piece of work which needs careful and extended investigation. To illustrate the matter,—the stem rust of wheat is not definitely known to attack any other type of shrub than the various species of barberry, *Berberis*. Our work during the past season shows that the charge against the barberry is well founded, and we believe that it can exercise very much greater influence upon the wheat crop than is usually supposed, for the definite reason that infection from the barberry may be transmitted directly to a number of the wild grasses, and they, in turn, multiply the rust with great rapidity, transmitting it in the air currents to adjoining wheat fields.

Flax and Its Diseases, Wilt and Rust: Extensive experiments were conducted during the season upon flax and its diseases, especially along the line of breeding and selecting with the view of obtaining information which will allow us eventually to procure flax strains which shall be "immune," or at least, highly resistant to the disease known as flax wilt.

Two hundred and twenty-six separate plot plantings of selected seed were made to test the various growth features of the wilt diseases and to determine the grade of immunity or resistance offered by the various selection types. These plantings were all made at Fargo, upon various types of flaxsick soil, checks being planted upon soil that had not previously been known to grow flax.

Forty-two plots of larger size representing as many strains of select flaxseed were planted upon flaxsick soil located near the town of Buffalo. These plots varied in size from one-twentieth to one-fourth of an acre, and were looked upon as increased plots for the various types of "immune" flax which had made the best yield records in previous years on the sick soil at Fargo.

The results of the season's work were most discouraging. Careful weekly notes, and, in cases, daily notes, were taken and records made of the flax growth upon the plots, and appearances and character of disease manifestations.

A new factor in the form of rust (*Melampsori lini*) came into marked prominence from its action this season. The disease has been generally prevalent throughout the state, but in many localities in 1905, became more destructive than it has been observed to be for a number of years. This rust is one which seems to be peculiar to the flax plant, and while it usually makes its appearance early in the season it does the most damage at the time when the crop is

forming the bolls. It has appeared each year in our breeding plots on the flaxsick soil and for some strange reason seems to grow worse each year upon the plants which have been the longest under culture. It is possible that this is only a seeming character. This season its work upon the so-called "immune" strains was very destructive, so much so that hardly any perfect seed was produced in any of the plots, and the strains which had previously given the finest growth and yield, such as immune Nos. 10-18, 22, and 45 were almost destroyed by this rust, in association with the beating rain-storms which occurred just at the time it was in boll formation. The rust was so pronounced upon these strains of long standing that we have decided that we must postpone the giving out of samples of the so-called "immune" seed, until it is learned wherein lies the source of the rust trouble.

Why these especially selected flax samples were so destructively attacked by rust both at Fargo and Buffalo, while ordinary field flax in the immediate neighborhood escaped with slight injury, is a matter of pronounced interest. We can only surmise. As rust attacked these pedigreed strains, whether they were planted upon flaxsick soil or upon soil that had not previously grown flax, and attacked the different samples, no matter what the date of planting, more severely than common flax which grew alongside of it, I assume that one of two things has happened. Either this species of rust is able to transmit itself from crop to crop by the seed and we have gotten all the selected samples thoroughly infected because of growing them in close association, or by growing these selected strains of flax continuously, year after year upon the same flaxsick soil, they have lost some feature of hardihood, and are thus left more susceptible to the attack of rust.

In either case, the hope of easily being able to furnish seeds of wilt resistant powers, has been rudely shaken; and it now becomes necessary to consider whether we can furnish wilt immune flax which can yield a crop in spite of rust. In neither case, however, is the matter hopeless. The fact that immunity to wilt exists in many strains of flax plants has been established. It has been established that this ability will persist from year to year, at least for five years. It has also been observed that some strains of flax exhibit very much greater powers of resistance to rust than others. It is, therefore, hoped that the same methods which we have been pursuing will eventually win out both in respect to rust and wilt.

Fortunately this work for rust resistance was already begun in 1904, and the results observed in the crop of 1905, were gratifying indeed.

Sixty-seven individual selections were made in 1904. Looking toward this end some of these selections showed marked improvement over any other flax growing under the same conditions, remaining green and finally maturing their seed in good form when other

samples were practically dead from rust action. The work of this department, we believe, is to establish the matters of fact with regard to such features of breeding in plant disease work. Thus, whether we eventually succeed in developing immune strains which shall persist in remaining immune under all conditions or whether we prove that such characteristics of immunity are temporary depending upon special conditions, we feel that the work must have great value to crop culture in general by establishing the facts in the matter. Our work of flax selection is pursued along two lines with reference to seed and fibre production. It is interesting to know that fibre strains of flax which are quite markedly resistant both to rust and wilt are much more easy to be obtained than those which belong to the seed strain. This we believe comes because fibre flax has been a matter of persistent cultivation for hundreds of years upon very confined areas of land, and there is therefore a better type of the survival of the fittest represented in the fibre strains than in the seed strains because the latter type of flax has been almost universally grown as a new land product.

Seed has been selected both for wilt and rust resistance from all our important selected strains and the work will be conducted during the coming year with renewed interest, but will be reduced to smaller and more exacting plot work with a view of being able to more closely control and observe the conditions of each plot. From the beginning, each selection has been given a definite number and a regular pedigreed record is kept of all samples so that it will be possible, after a number of years, to learn whether a particular strain is improving or losing in its resisting powers. Previous work demonstrated the importance of equality in depth of planting when comparing the growth of flax crops. To be certain that all samples to be compared should have exactly the same conditions, the department has constructed a centgener planting machine of such nature that seeds can be planted at any desired depth, and all those of a given bed at exactly the same depth. A small hand threshing machine was also constructed in such form that small plots of grain may be threshed without giving any chance of mixing the different strains of seed.

CROSS FERTILIZATION IN FLAX.—Common cultivated flax has usually been supposed to be self fertilized, though the character of the blossoms would indicate that cross fertilization would be possible, even quite probable. It was easily recognized that this might play a large role in the matter of retention of such qualities as rust resistance or wilt resistance. Cross fertilization experiments were conducted during 1904 and were continued in 1905. The work will be continued another season before report is made upon it in detail.

FLAX FIBRE.—Experiments at this station during several years previous have shown that the soil of the Red River Valley will produce flax straw of as great length as is ever demanded by the fibre

man. This department has planned some retting experiments to test the quality of the fibre. A part of these experiments have been conducted on the dew-retting plan in general use by the Russian peasants. The results show that this type of work can be well done in the spring season in North Dakota; and the fibre which we have been able to make from North Dakota straw compares favorably with the best European grades.

Retting tests by exposure to winter snows proved of no effect. Wintering action on exposed flax straw is not equal to the action of dews and rains of a week in spring season.

POTATOES AND POTATO DISEASES.—Potato diseases of all of the various types characteristic of older regions are gradually making their appearance in the new land of Dakota. Most of these diseases are preventable ones, provided farmers will take the trouble of treating their seed tubers for those diseases which are planted with the seed pieces, and spray for those which spread by way of the vines from field to field. It seemed, however, possible that types of potatoes might be bred which would prove more resistant to some of the common diseases, such as blight and rot. The work was started in 1903 and 1904 and quite an extended variety test was carried out during 1905.

Sixty-seven separate plantings were made, including some thirty odd varieties of potatoes. A piece of ground was selected for the experiment, which was noted for the fact that in previous years fully one-third to one-half the crop had usually died from potato blight and rot. Another portion of ground was filled with potato offal, including diseased vines of a previous crop, and the potatoes tested upon this plot. This type of ground was selected with the point in mind that such thoroughly diseased land would be apt to destroy all non-resistant types. The season was not a good one for the work. It spoiled all possibility of making a very accurate comparison between the yields given by the different varieties as the wetness of the season just preceding digging time, after the crop had matured, caused most varieties to rot profusely from ordinary bacterial decay. Records, however, were taken and may prove eventually of more interest than now appears.

From the beginning of the growth period it was evident that some varieties were much more resistant to blight and ordinary potato diseases than others. It was also evident that some individual plants within the varieties had marked resisting powers as compared to the average. I do not think it wise to publish the details of this experiment, as it might be unjust to many varieties. Such experiments must be extended over a number of years before one is justified in drawing definite conclusions for or against a particular variety.

COMMERCIAL CULTURES FOR LEGUMES.—Numerous questions have been sent to the department by farmers throughout the state concerning the value of soil inoculation in order to procure a stand

of alfalfa and clover or other legumes. While our previous investigations had demonstrated to us that the new lands of this state are thoroughly infected with the organisms which produce root tubercles, upon legumes, including vetches and numerous other legumes, it was thought advisable to procure some of the commercial cultures, and also some cultures from the Department of Agriculture to make a test upon our grounds. The various types of seeds which were used were secured from Magill & Co., of Fargo. The pure cultures, used, were obtained from the National Nitro-Culture Co., of Pennsylvania, and also a set from the U. S. Department of Agriculture. The directions for the use of each were carefully followed with one or more checks, using distilled water instead of ordinary rain water, as was done for the regular work. Both types of culture were used upon the following seeds: crimson clover, alsike clover, Swedish garden beans, garden peas, alfalfa, common red clover, and white clover.

All of the cultures gave the milky colored fluid, as described by the department, at the proper time. When examined under the microscope it was found that the cultures contained numerous organisms, bacteria and yeast types, but it was impossible from ordinary microscopic mounts to discover that the solutions did or did not contain any organisms of the type known as *Pseudomonas radicola*, the organism of root tubercle formation. Pure cultures were not made from these inoculation cultures, so we are not certain whether they contained the proper organisms in quantity or not. The seed, however, were treated as per direction and planted in small separate beds with an associated check bed in which the seed were not treated at all. Observations were made upon the growth of each during the growing season. No distinction could be drawn between treated and untreated plots. At maturity both treated and untreated plots were found to possess an abundance of nodules.

In the light of the extensive experiments recorded in New York Experiment Station Bulletin No. 270, we think it is possible that there may not have been any perceptible quantity of living *Pseudomonas radicola* in the cotton wudges which were received for the work. At any rate the test shows that no good could come from the use of commercial cultures upon soil similar to that which could be found here on the Station farm. The writer is inclined to believe that the new soils of North Dakota, at least the Valley lands, are not in need of any introduction to the nodule producing organisms. If any farmer really wishes to make a soil inoculation, it will be a simple matter to transfer some soil in which either clover or alfalfa has been growing to the land he wishes to test, being careful to avoid selecting soil from old lands which may possess disease producing fungi such as potato scab, potato rot, etc.

TREE FEEDING EXPERIMENT.—Because of the immense amount of work which the experiment demands, and the slight amount of

time available for the work of tree feeding experiments, which have been conducted for a number of years, were discontinued during 1905. But observations were continued upon the trees which had been previously treated for diseases such as apple-blight and plum-pocket. It was observed that trees which were treated for apple-blight in 1904 remained quite healthy during the season of 1905 and produced fruit. But the season of 1905 was characterized by a very slight development of blight in the orchard generally. It was observed that native plum trees which had been treated for the prevention of plum-pocket (*Exoascus*) still produced some diseased fruits, but much less than the untreated trees in the immediate vicinity. They also fruited much more completely and perfectly than the immediate neighboring untreated trees. This may be but a coincidence and need further demonstration.

GRASS GARDEN AND NATIVE FORAGE STUDIES.—Some new plantings were made in the grass, forage and weed garden. Through the aid of Student Assistant Mr. D. Glomset all of those beds, which were previously developed, were kept in good condition. The garden has been of much use to us during the season as a place for the study of rust development upon native plants. Many of the grasses and some of the new forage plants developed wonderfully fine growths of forage, demonstrating that some of our native grasses and native plants, when given an opportunity to grow unrestricted by the development of other plants, may prove of great agricultural value. Some feeding tests have been planned to test some of these to ascertain whether they are relished by stock or otherwise. In some cases in which wonderfully fine growth of forage is developed, resulting in the production of fine sods, there is still a tendency not to produce seed. And it is a question whether some of our very best native grasses can be put under general cultivation for this reason.

HENRY L. BOLLEY,
Botanist.

AGRICLTURAL DEPARTMENT

To Director J. H. Worst—

Sir: In submitting to you the Sixteenth Annual Report of the Agricultural Department I take pleasure in stating that the work has been expanded in the line of livestock investigation and that it has maintained its previous standard in quality and efficiency.

I regard it a matter for congratulation that no change among our staff of expert workers has occurred since my last annual report was submitted to you.

The results secured from completed trials and from the preliminary operations which necessarily precede successful agricultural experiments indicate marked progress.

Response to a demand from the public schools for instruction in agriculture has forced me to leave the important lines of soil cultivation and soil moisture study almost exclusively for future consideration.

I have noted many interesting phenomena during the past season which indicate that results of importance to soil moisture students have been allowed to pass unrecorded by reason of a lack of time to make a study of them. As you have already provided relief from the extra instructional duties mentioned above I trust that data upon this subject may be recorded and steadily accumulated in the future, as it is a vital question in its bearing upon crop production.

It is needless to call your attention to the fact that the experimental grounds connected with this institution are, by reason of their natural uniformity, better suited to comparative soil moisture studies than any similar piece of ground in the possession of a Government Experiment Station in the Northwest.

I can conscientiously commend the efficiency of the corps of men employed as assistants in this Department.

It has seemed advisable for one of the workers and myself to spend a considerable amount of time instructing teachers in their collective organizations upon the subject of Agriculture.

During the past year we have prepared a text-book suited to their needs and by addressing their public meetings and summer school session have given direct instruction especially adapted to

their work. A second member of the force has spent some time in aiding the breeders of blooded stock in the capacity of Secretary of their organization. That work—which is not only a service to the state that is worthy of our attention, but which is also one that serves to bring the institution in close contact with the breeders of improved livestock—gives one of the most enlightened classes of our farmers a chance to keep in close touch with the institution and its work. A third member of the working force of this Department has spent some time on the Farmers' Institute platform of the state, urging the advantage of using suitable seed, the necessity of good cultivation and the fundamental importance of adopting a reasonable system of rotating crops.

The work of answering letters of inquiry upon specific agricultural topics has made a noticeable increase during the past year, but I have been able to pass enough of it over to my assistants to prevent it from becoming more of a burden upon me than it has been heretofore. For the year included between the dates February 1st, 1905, and February 1st, 1906, 1,778 pages of letter records measure the correspondence work of the writer.

The most urgent need of the Department is a suitable seed building. At present the illy adapted space which is available is so limited as to render it impossible to carry and increase many of the strains of seed which should be kept for further experiment and distributed to the crop grower of the state. Constant vigilance is required to prevent serious inroads by mice and damage from vermin is not infrequent even with close attention. With good facilities damage of that sort would be greatly reduced.

The United States Department of Agriculture has planned a marked extension of the co-operative work to be conducted by the Station over that which was carried last season. The lack of suitable facilities and storage places for our grain breeding samples, places that work somewhat in jeopardy and the expressions of confidence in our studies by the U. S. Department makes it especially deplorable that the state, which is almost the sole beneficiary, does not provide better facilities for the work.

During the past year the workers in this Department have put out the following publications: A text-book upon Elements of Agriculture, Bulletin 64 Root Systems of Field Crops, Bulletin 65 Clover and Alfalfa Culture, seed train bulletins entitled, Selecting Seed Grain, Grading Seed Grain, and Seeding Grain—the latter three of which were designated "Soo Line Seed Special" Bulletins numbers 1, 2 and 5.

The Department workers have responded to numerous requests for special papers, addresses and press articles during the year.

The duties which you have assigned to me relative to the work of the Sub-Stations have required about the amount of time which might be expected from the nature of the work.



NO. 52—FRANCIS HALL, AUGUST 14, 1905



PLANT BREEDING.

The work of plant breeding in co-operation with the Bureau of Plant Industry, Department of Agriculture, Washington, D. C., has been conducted along the lines followed in previous years.

The results from individual plant study in the plant breeding nursery work for 1905 differs little from that carried on during previous seasons, except that the results from hybridization between blue stem wheat and emmer are now growing more marked and differentiated.

The study of individual ear corn breeding has taken on added interest by reason of the successful maturing of plants from seed of the original stock grown eleven years previous and stored at the College during the interval. It would be hazardous to draw conclusion from a single season's results, as the plants which have sprung from a mummy ancestry of eleven years standing, may lack in vigor and rapid development even when it is not apparent. Whatever the cause the fact remains that the plants grown from the old seed matured nearly two weeks later than did those from the sort which had been selected for the eleven generations. The work in corn breeding has consisted in a selection for earliness, large yield and high protein content.

In 1905 the plant nursery of small grain, millet, alfalfa, and corn represented a total of 49,500 individual plants as follows:

	Individual Plants.
Wheat	14,200
Oats	4,300
Barley	4,300
Flax	4,400
Buckwheat	1,600
Millet	3,700
Emmer	200
Spelt	100
Einkorn	100
Spring rye	100
Golden Dent Corn.....	8,000
N. D. Sta. No. 100.....	6,000
Alfalfa	2,500
Total	49,500

The nursery wheat breeding trials for 1905 consisted of the following:

	No. of Plants.
Eighteen stocks of fixed type.....	6,100
Thirty-six blue stem stocks of fixed type.....	3,100
Cross bred plants	2,400
Durum varieties	1,800
New unfixed types	800

Making a total of.....14,200

The chief points sought have been yield, grade, rust resistance, and stiffness of straw.

The oat breeding work has consisted of the following stocks of seed:

	Plants.
Branching oats, six stocks of fixed type.....	3,300
Side oats, one stock	900
Cross bred oats, one stock.....	100

Total 4,300

Yield, a high percentage of kernels to husks, stiffness of straw, and rust resistance are the points sought in the oat breeding work.

Five stocks of barley were planted as follows:

	Plants.
Six-rowed barley, four stocks.....	2,800
Two-rowed barley, one stock.....	1,500

Total 4,300

Yield, grade, stiffness of straw, rust resistance, and freedom from beards are the points selected for in this experiment.

Flax is being bred to two types, one for seed, the other for fibre. The number of plants grown in each stock are as follows:

	Plants.
Flax bred for fibre.....	1,700
Flax bred for seed.....	2,700

Total 4,400

The extremes between the two types show a very marked difference. We have found the flax plant very plastic to produce new forms and persistent in retaining the characters which it acquires.

In buckwheat the chief work has been with the common sort as foundation stock. The progress in the work with buckwheat has been slow and it seems certain that it will require considerable time to make this cereal capable of much productive value in North Dakota.



NO. 53—OAT VARIETY TRIALS, AUGUST 14, 1905

The breeding of millet has consisted in three different breedings which have sprung from a common stock. First, a selection for seed production alone, a second stock selected for fodder plants alone, and a third, one bred for both seed and fodder. A total of 3,700 individual plants of millet were produced in the season of 1905.

Two hundred plants of emmer were grown in order that a selection for yield improvement could be made, while one hundred plants each of spelt and einkorn were matured for a study of their degree of success and consequent value for this district.

Alfalfa plants to the number of 2,500 were grown chiefly for the purpose of selecting rugged, healthful types.

Twenty-two varieties of alfalfa were planted in small trial plats without a nurse crop on May 25, 1905.

Thirty-three small plats of wheat, forty-two of oats, eighty of barley, and thirty-one of millet, were grown from seed sent the Station by the United States Department of Agriculture. Some of the millets were promising, but this list of cereals as a whole did not show much promise. Flooding by water from the heavy rainfall, mentioned elsewhere in this report, injured this trial severely, although it was placed upon one of the best drained pieces of ground in the possession of the College.

The same varieties of grain were grown from seed supplied by the U. S. Department of Agriculture this season as were reported upon for last year. The excessive rainfall at harvest time made it impossible to secure data upon this trial, although by hard work and much wading through mud and water enough heads of each variety were secured to make it possible to seed them in the trial for 1906.

Photogravure illustrations published herewith indicate the conditions which surrounded us at harvest time in 1905. Photograph No. 52 shows the situation at Francis Hall (the agricultural building) on August 14th, just when the grain was ripe. No. 53 is a scene on our oat trial grounds August 14th, while No. 54 gives a view upon another portion of our experiment grounds upon the same date. Photographs submitted herewith of the binder appliances used for cutting grain in wet land shows the contrivance with which we finally harvested our trial plats of grain.

The meteorological records of the institution give the following data relative to the rainfall in 1905.

In May 5.77 inches of water fell during 16 rainy days.

In June 5 inches of rain came in 17 days.

In July 5.17 inches of rain occurred and 14 days are listed as rainy ones.

In August 6.82 inches of rain fell during 13 days, making a total for the four months of 22.76 inches of rainfall, which is 1.86

inches more water than is represented by the average annual precipitation for the thirteen years which preceded it.

Over two thousand bushels of pedigreed seed have been distributed, chiefly by sale, to over eight hundred people. As the details of this work are discussed at some length on pages seventy to seventy-two of the Fifteenth Annual Report it will not be necessary to repeat the facts here.

MEDIUM RED CLOVER.

Twenty samples of red clover seed from different states and countries are being tested in a co-operative experiment with the Bureau of Plant Industry of the United States Department of Agriculture. This trial is a continuation of one begun in the spring of 1901.

The names given the seed samples indicate where they were grown, with the exception of the sorts called "western bulked," which were secured upon the clover seed markets of western cities and are doubtless an admixture of seed from the various sources from which they are able to purchase clover seed for their trade.

It will be noted that the clover seed used in this trial can be grouped as coming from three belts of states, viz., Michigan and Wisconsin, east and west Ohio, North and South Indiana, Illinois, Iowa and Nebraska, and from Kentucky, Tennessee and Missouri. In addition to this list Oregon and Russia are represented.

The land upon which the clover was sown produced corn in 1902, barley in 1903, and the clover was seeded with a nurse crop of wheat in 1904. The field had been fall plowed. Frequent heavy rains in the spring of 1904 made the soil very wet and compact, while later in the season it became dry and the soil baked, leaving it in a very poor condition. The fife wheat used as a nurse crop was sown at the rate of five pecks per acre on May 12. Four days later the clover was sown at the rate of slightly less than ten pounds per acre. The clover was sown by hand and covered by harrowing once with a peg tooth harrow. One-half acre plats separated by twelve foot alley-ways were used for each variety.

By June 15 the wheat had made a small growth above the surface and the clover was coming up nicely. The clover looked better on the higher and mellower spots of the almost level and very uniform field. On July 25th the wheat which was just forming kernels was cut for hay. The sickle bar was set as high as possible and left the stubble about five inches high. The best of the clover was so high that it was clipped by the mower.

On August 2nd notes were carefully taken upon the stand and condition of growth of the different plats. Plats 6 (Missouri seed), 12 (Eastern Ohio seed), and 15 (a Russian sample) showed the best stand and most thrifty appearance with plats 5 (Illinois seed), and 19 (Wisconsin seed) ranking very close to them. On October



NO. 54-SCENE ON THE TRIAL GROUNDS AT FARGO, AUGUST 14, 1905

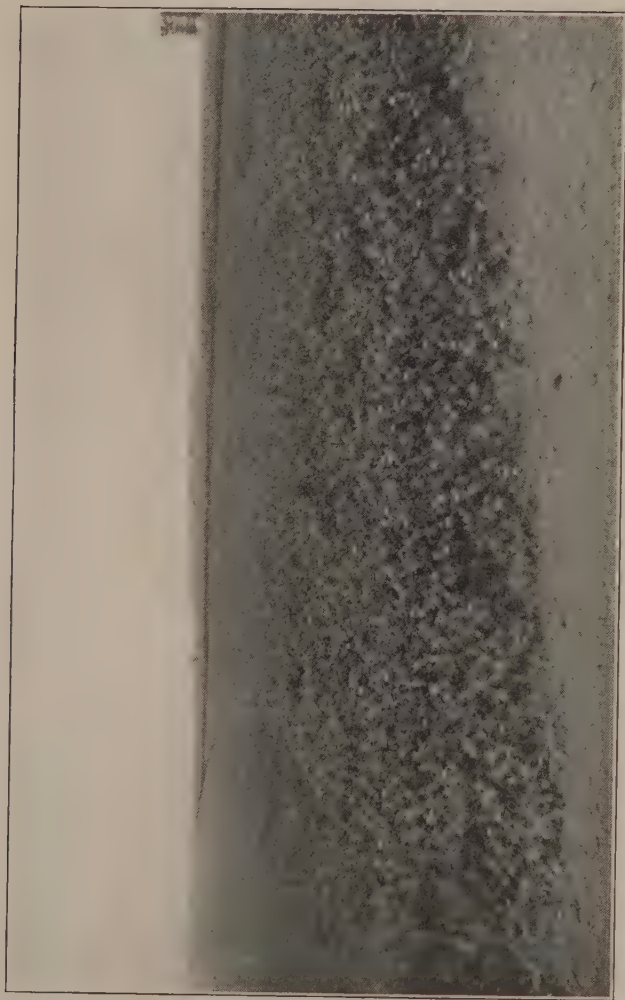
5th plats 5 (Illinois seed), and 19 (Wisconsin seed), had the best general appearance. While there was quite a noticable difference between the different clovers at this time all of the sorts were very promising in appearance.

On October 25th, when a killing frost occurred, there seemed to be sufficient covering of clover and of wheat stubble to afford a moderate winter protection.

The following table gives in condensed form the data secured from the first cutting of hay in 1905:

TABLE A—Medium Red Clover—Grown in a Co-operative Test with U. S. Dept. Agr.—1905

Plot No. 44	Accession No.	Source of Seed	Stand-Spring 1905	Date First Bloom	Date Full Bloom	Habit of Plant	Height, Inches	Size of Plot Acres	Texture of Stem	Healthiness of Stem	Strength of Stem	Texture of Leaf	Healthiness of Leaf	Abundance of Inflorescence	Date First Cut	Yield per Plot Pounds	Yield per Acre Tons	Percent Shrinkage in Airing
1	1258	Western Bulkcd	99	6-26	*	Recumbent	31 ½	½	mostly coarse med. but tough	Med.	85	Med.	Slight	Very little	7-8	2610	2.61	73
2	1259	Western Ohio	94	6-20	7-7	Recumbent	27 ½	½	fine	Slight	92	Thin	Slight	Very	7-8	2475	2.47	77
3	1260	Northern Indiana	94	6-20	7-7	Recumbent	29 ½	½	fine	Slight	85	Med.	Slight	Very	7-8	2242	2.24	79
4	1261	Southern Indiana	94	6-20	7-7	Recumbent	28 ½	½	med. to coarse med., some coarse	Slight	88	Med.	Slight	Med. to very	7-8	2430	2.43	80
5	1262	Illinois	100	6-20	7-7	Recumbent	28 ½	½	fine	Quite	80	Coarse	Med.	Very	7-8	2415	2.41	79.5
6	1263	Missouri	94	6-20	7-7	Recumbent, many plants erect	29 ½	½	fine	Med.	94	Coarse	Slight	Very	7-8	2755	2.75	81
7	1264	Iowa	94	6-20	7-7	Recumbent, many plants erect	29 ½	½	med.	Slight	90	Coarse	Slight	Very	7-8	1980	1.98	79
8	1265	Western Bulkcd-1	96	6-20	7-8	Recumbent, many plants erect	31 ½	½	mostly coarse	Med.	85	Med.	Slight	Very little	7-8	3030†	3.03†	81.5
9	1267	Western Bulkcd-2	80	6-20	7-7	Recumbent, many plants erect	31 ½	½	mostly coarse	Med.	85	Med.	Slight	Med.	7-8	2070	2.07	80
10	1268	Michigan	85	6-20	7-7	Recumbent, some recumbent	32 ½	½	coarse	Slight	96	Med. to Coarse	Quite	Very	7-8	1875	1.87	74.5
11	1269	Nebraska	97	6-20	7-7	Recumbent, some plants erect	28 ½	½	coarse	Very	90	Coarse	Quite	Very	7-10	2540	2.54	69.5
12	1270	East Ohio	98	6-20	7-7	Recumbent, some plants erect	32 ½	½	coarse	Very	96	Med. to Coarse	Quite	Med.	7-10	2860	2.86	80
13	1271	Kentucky	86	6-20	7-7	Recumbent, some plants erect	27 ½	½	coarse	Very	94	Med.	Med.	Med.	7-10	2305	2.30	80
14	1272	Tennessee	87	6-20	7-7	Recumbent	30 ½	½	coarse	Very	95	Coarse	Med.	Very	7-10	2545	2.54	78.5
15	1273	Russian-1	96	6-20	7-7	Recumbent	28 ½	½	coarse	Few	96	Coarse	Slight	Few	7-10	2100	2.10	80
16	1274	Russian-2	90	**		Recumbent	34 ½	½	med.	Few	94	Fine	Slight	None	7-10	2031	2.03	73
17	1275	Russian-3	84	6-23	*	Recumbent	28 ½	½	med.	Few	90	Fine	Slight	Very little	7-10	2175	2.17	79.5
18	1276	Russian-4	84	6-20	7-7	Recumbent	30 ½	½	coarse	Few	96	Thin	Slight	Med.	7-10	2235	2.23	78
19	1277	Wisconsin	97	6-20	7-7	Recumbent, some erect	28 ½	½	med.	Quite	80	Coarse	Med.	Very	7-10	2190	2.19	78
20	1278	Oregon	90	6-20	7-7	Erect, some recumbent	28 ½	½	coarse	Quite	92	Med.	Med.	Very	7-10	2150	2.15	77.5



NO. 35—RED CLOVER TRIALS 1905

The figures given in the column headed "percent. shrinkage in curing" were obtained by weighing 100 pounds from each plat when it was cut and weighing it when ready to store. The loss in weight divided by the green weight is taken as the percent. of shrinkage in curing. The loss is almost entirely due to the drying out of the moisture, although a few leaves were lost in curing. Hay, when fully cured and stored, still contains from ten to twenty per cent of moisture.

The table shows a remarkably heavy yield of cured hay, the amount ranging from 1.87 tons to slightly more than 3 tons per acre. The lack of an experiment seed building made it impossible to determine the absolute dry weight of these different samples, and as the three ton sample was rather green at the time of cutting, the yield recorded may have been slightly too high.

The remaining columns of the table require no explanation.

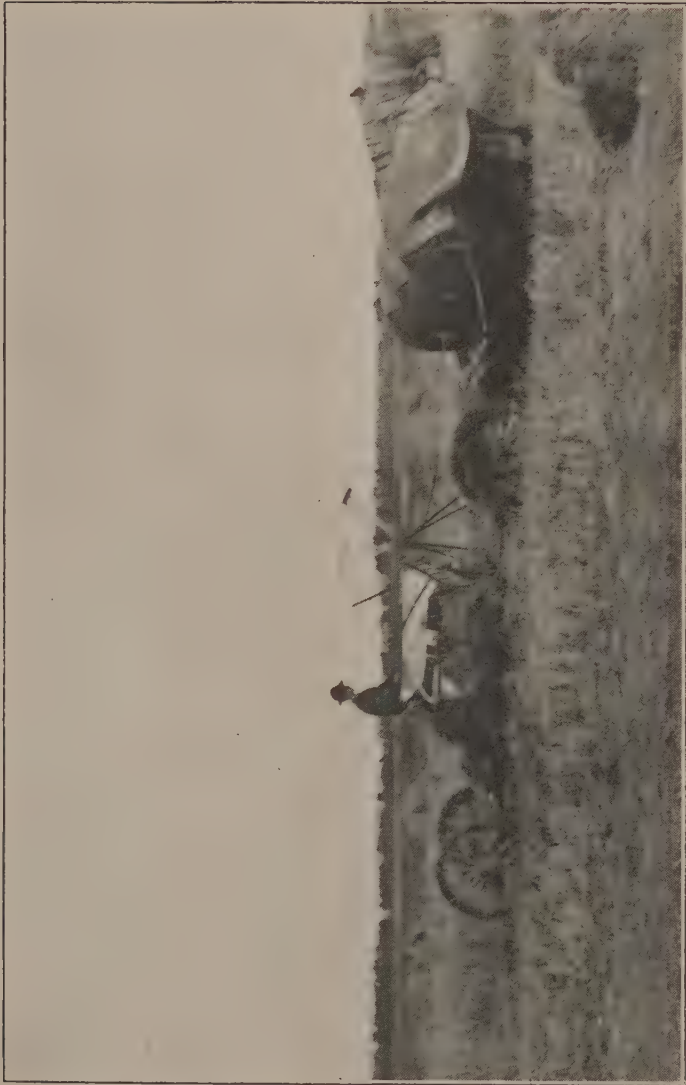
Plat 16 (one of the Russian strains) was cut very green and the yield is much less than it would have made had it been allowed to reach the same stage of maturity the others had before cutting. Plats 1 (Western bulked seed) and 17 (Russian No. 3) were also cut somewhat too green. The rest had made about the same advancement when they were cut July 8th and 10th. The three late maturing ones (1258 Western bulked, 1274 Russian, and 1275 Russian) were cut at this time so that they might all have the same opportunity to produce seed.

A few plants of dodder were found in plat 6 (clover seed from Missouri). Dodder is an extremely dangerous and noxious weed in clover and alfalfa fields, and buyers should be very cautious in purchasing these seeds, especially from dodder infected districts. Many plants in plats 12 (East Ohio seed), 13 (Kentucky seed), and 14 (Tennessee seed) were affected with a fungous growth upon the stem. The fungus causes the stem to decay where infected, thus killing the whole plant. Plat 14 (Tennessee seed) was affected much worse than plats 12 (East Ohio seed) and 13 (Kentucky seed) with this disease. It will be noted that the seed grown on these plats came from rather close lying districts and where these diseases are common. The rest of the plats were extremely free from fungous diseases and harmful insects. Too much care can not be taken in purchasing seeds to have them pure and of good quality. Many of our worst weeds and plant diseases are introduced in the seed.

The clover made a rapid second growth and was ready to cut about September 10th. On September 19th each plat was divided into two equal parts and one-half of each was cut for hay while the other was left to ripen seed. On October 9th a heavy killing frost occurred. The clover was cut for seed with a self rake reaper on October 11th. The reaper left sufficient stubble to make a good winter protection. The part cut for hay made enough growth to

give moderate protection, but was not as well sheltered as that cut for seed.

The general notes for this cutting are practically identical with those for the first crop. Table B gives the data secured on the second crop, the seed notes, and also the summarized data on the crop for the season of 1905.



HARVESTING GRAIN WITH BINDER MOUNTED ON WAGON TRUCK, SEPTEMBER 1905

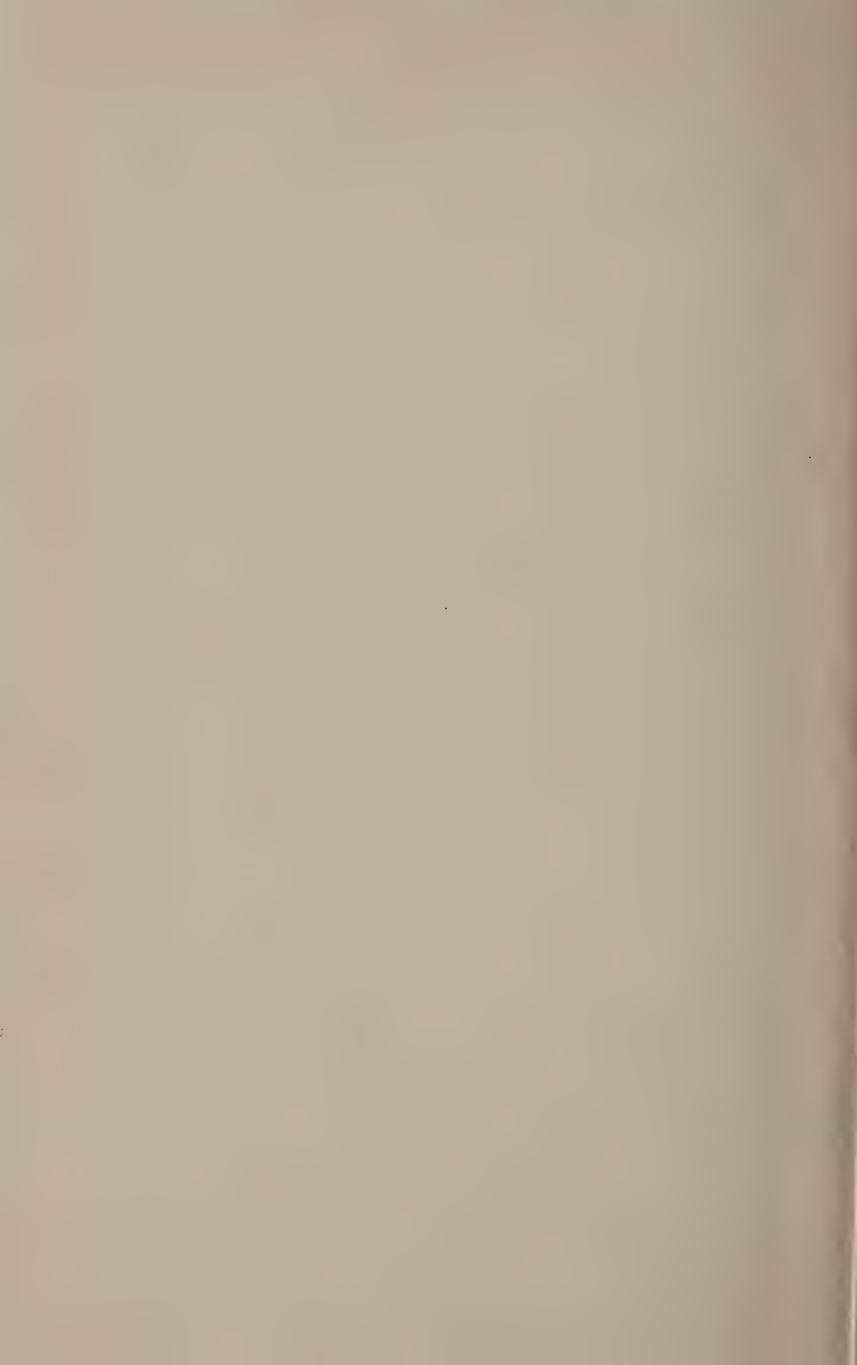


TABLE B.—Varieties of Red Clover—Second Cutting and Seed Notes—1905

Plot No.	Accession No.	Source of Seed	Date Cut for Hay	Stand	Height—Inches	SEED			YIELD PER ACRE		Yield of Hay per Acre for two cut- tings—Tons
						Stage of Maturity when cut	Quality	Pct. of good Germination	Hay—Tons	Seed lbs.	
1	1258	Western Bulkcd	September	100	32	50% ripe	Good	....	2.00	42	4.61
2	1259	Western Ohio	September	100	30	65% ripe	Good	....	1.76	62	4.23
3	1260	Northern Indiana	September	100	30	65% ripe	Good	....	2.20	82	4.44
4	1261	Southern Indiana	September	100	29	65% ripe	Good	....	2.06	78	4.49
5	1262	Illinois	September	100	29	65% ripe	Good	....	2.02	104	4.43
6	1263	Missouri	September	100	30	65% ripe	Good	....	2.26	102	5.01
7	1264	Iowa	September	100	31	65% ripe	Good	....	2.23	84	4.21
8	1265	Western Bulkcd-1	September	100	31	65% ripe	Good	....	2.43	136	5.46
9	1267	Western Bulkcd-2	September	100	32	65% ripe	Good	....	2.38	104	4.45
10	1268	Michigan	September	100	32	65% ripe	Good	....	2.15	110	4.02
11	1269	Nebraska	September	100	32	65% ripe	Good	....	2.37	98	4.91
12	1270	East Ohio	September	100	32	65% ripe	Good	....	2.34	58	5.20
13	1271	Kentucky	September	100	28	65% ripe	Good	....	3.12	78	5.42
14	1272	Tennessee	September	100	30	65% ripe	Good	....	1.70	64	4.24
15	1273	Russian-1	September	100	28	65% ripe	Good	....	1.96	52	4.06
16	1274	Russian-2	September	100	18	5% ripe	Fair	....	1.13	20	3.13
17	1275	Russian-3	September	100	29	60% ripe	Good	....	2.30	66	4.47
18	1276	Russian-4	September	100	30	65% ripe	Good	....	1.93	106	4.16
19	1277	Wisconsin	September	100	30	65% ripe	Good	....	2.20	146	4.39
20	1278	Oregon	September	100	32	65% ripe	Fair	....	1.64	104	3.79

The seed planted on plats 1, 8, and 9 had the same source, and was identical in every way except that the seed planted on plat 9 had been inoculated. No difference could be detected in the thriftiness of these plats at any stage of their growth and the yield shows no advantage whatever from inoculating the seed. Where the roots of plants from each plat were washed out the tubercles appeared as plentiful on the uninoculated as upon the inoculated. This test goes to substantiate previous results secured in similar trials and indicates that it is entirely unnecessary to inoculate soil for red clover on our trial grounds.

The season of 1905 was an exceptionally good one for clover and the yields were greater than can be expected in the average season.

Following are yields secured from the first cutting of clover on the Station grounds during the six years of the trial:

Year.	Kind of Clover.	Yield of Hay, per acre.	
			Lbs.
1893	Medium red		2070
1894	Medium red		3225
1895	Mammoth		5000
1896	Medium red		2275
1903	Medium red		3659
1905	Medium red		4760

Average yield from first cutting in six years.... 3498

These yields can be taken as positive evidence that red clover, if properly treated, can be successfully grown in the Red River Valley region of North Dakota.

From the seed notes it will be seen that red clover seeds freely even in wet years. The plat giving the highest yield lacked only four pounds of making two and one-half bushels of seed per acre. Clover seed is valued at \$12.00 to \$16.00 per hundred weight. Taking the average of this, or \$14.00, the value of clover seed from this plat would be \$20.44 per acre. Taking the average yield per acre for the twenty plats at the same price and it would give an average value of \$11.67 per acre for the ten acre piece. A crop of hay is always secured before the seed crop, as medium red clover produces seed in the second growth. The value of clover to the land upon which it is grown is not exceeded by any farm crop. In old clover growing sections the land is broken after one crop of clover is secured, as that is considered the most profitable method. These plats will be left, however, as long as they give fairly good yields, to determine how long clover will persist under these conditions.

In the spring of 1905 plats were seeded to medium red clover, Mammoth clover, and alsike clover with and without a nurse crop. Wheat seeded at the rate of four pecks per acre was used as the nurse crop. The wheat was drilled on April 14 at a depth of about

three inches. The clover was then broadcasted and covered by harrowing once with a peg tooth harrow. About twenty pounds of clover seed was used upon an acre of land. The resulting stand showed that ten pounds of seed would have been sufficient. The stand was altogether too thick to secure the best results. A plot of land was seeded to red clover, the seed of which was secured on the campus of the College. Clover was sown on this ground eleven years ago and has persisted until the present time. This seed should prove to be a very hardy strain.

The wheat nurse crop was cut on August 30th, at which time the clover had made a tall, rank growth reaching a height of 20-28 inches. The clover seeding did not suffer from the heavy rains as the alfalfa did, although they were planted side by side on uniform ground. These trials are being made to determine the best method of seeding clover and to learn the relative value of the different kinds. The season of 1905 proved to be an exceptionally good one for clover seeding.

ALFALFA TRIALS.

The results secured from the old pieces of alfalfa (seeded in the springs of 1901 and 1902 respectively) can be found in Bulletin 65. The stand upon these old pieces was not injured in any way by the winter of 1904 and 1905, which represented their third and fourth winter seasons. These old pieces of alfalfa were not injured during the summer by the excess of rain as were the newly seeded ones, as the rapid growth of the plants kept the standing water a few to several feet below the surface during the wettest time, when a portion of the land adjoining it containing cultivated crops had water standing upon the surface. Alfalfa does not do well when so much water is present as to bring the water table near the surface of the ground, but the rapid growth which this thrifty alfalfa put on made it use the large supply of water which fell last summer as fast as it came. This disposition on the part of alfalfa to consume large quantities of water may mean that lands having standing water near the surface may have it reduced enough by a growth of alfalfa to change it into a satisfactory environment for that crop.

On June 27th the alfalfa was cut for the first crop of hay. The following observations were made on that date:

The Turkestan variety was 36 inches high and formed 90 per cent of a stand. Three per cent of the plants were in blossom. The growth was very heavy and most of the plants had an erect habit of growth, although some of them were reclining and still others were lodged. The stems of the Turkestan alfalfa were somewhat coarse. There was no fungous or other disease present. Many of the lower leaves were yellow, probably because the growth was so very heavy. This plat consists of two acres and gave a yield of 9,490 pounds of hay or 2.37 tons per acre. The second growth was as heavy as the

first. It was ready to be cut for hay by July 30, but was allowed to produce and ripen seed. Alfalfa usually seeds well on the station plats, but this year there was too heavy a growth of stems and foliages for seed production.

The Turkestan alfalfa plat seeded in 1902 was cut on July 1. The notes on the preceding plat will answer for this one also. This plat gave a yield of 2.34 tons of hay per acre. No seed was produced, although it was allowed to become fully mature.

The Grimm alfalfa seeded in 1902 was cut July 1. It was slightly further advanced than the Turkestan alfalfa plats. It is finer stemmed and produces more branches and leaves than the Turkestan strain. The stand is excellent. No seed was produced on this plat.

The one cutting of Grimm alfalfa gave a yield of 3.24 tons per acre. The second crop was as large as the first one, but it was left to ripen seed.

June 6, 1904, a strip of land $18\frac{1}{2}$ feet wide and 16 rods long was seeded to Grimm alfalfa. This strip was then divided cross ways into several plats and each was given some special treatment. This experiment is designed to determine the effect upon the growth of alfalfa made by the application of lime and from adding dirt infected with alfalfa bacteria and a combination of the two. The plats were small and the crop was not weighed, but no difference could be detected in the stand or general thriftiness between any of the plats. The nodules on the roots caused by the alfalfa bacteria were found to be as prevalent where no dirt was added as they were where the largest quantities were applied.

Several new seedings of alfalfa were made in the spring of 1905. Six varieties each consisting of one-sixth of an acre were put in as a variety trial. A plat of one acre was seeded to Grimm alfalfa with seed secured from the 1904 crop. Besides the foregoing, twenty-five small samples secured through the United States Department of Agriculture from different countries were seeded in the alfalfa nursery. These tests are made to determine the relative hardiness and adaptability to North Dakota conditions.

Two plats of one-half acre each were seeded to Turkestan alfalfa. On one a nurse crop of wheat was seeded, while the other had no nurse crop. A strip of land sixty-eight feet wide across both plats was given an application of alfalfa bacteria infected dirt, which was applied at the rate of 100 pounds per acre. This trial was made to determine the effect of using a nurse crop and to determine the results from applying bacteria.

POULTRY WORK FOR 1905.

As you have asked for a bulletin on poultry during the coming season only a business record is submitted in this report, which indicates the amount of stock on hand and the disposition of fowls and eggs during the past year.

The poultry house belonging to the institution burned to the ground early in December, 1904, which forced me to assign the poultry to very unsuitable quarters in the horse barn until spring, and then to poor temporary quarters in the yard until autumn.

It was impossible to get good results or to carry on experiments of much value with such conditions.

A College student, Oliver Dynes, has had charge of the poultry for the year, but his College duties prevent him from giving the little frequent attention to the poultry which is of such vital importance to fowls. Interesting egg laying trials are now under way and grade breeding trials which have been carried for three years have given pronounced results which I hope to incorporate in the poultry bulletin which you have requested.*

EGG RECORD OF SEVENTY HENS PER MONTH FOR 1905.

January	298
February	443
March	972
April	1315
May	1144
June	725
July	567
August	588
September	599
October	380
November	42
December	73

Total.....7,146

Or 595½ dozen

EGGS SUPPLIED TO FARM HOUSE.

	Doz.	Price.	Total
January	22	\$.30	\$6.60
February	30¼	.30	9.08
March	64	.18	11.52
April	64	.15	9.60
May	57	.15	8.55
June	49½	.15	7.42
July	43½	.20	8.70
August	41½	.20	8.30
September	29¼	.25	7.31
October	31½	.25	7.88
November	26	.30	7.80
December	26½	.30	7.88

Total \$100.64

Eggs set for hatching.....	628
Eggs broken in nest:.....	57
Eggs unfertile or died in embryonic stage.....	135
Number of fertile eggs.....	69.3 per cent, or 436
Number which died in the shell.....	76
Number of chicks	82.3 per cent, or 360
Number of chicks raised.....	54 per cent, or 194

UNDRESSED POULTRY SUPPLIED TO FARM HOUSE.

	Lbs.	Price	Total
January	14	\$.11	\$1.54
September	38	.13	4.94
October	54½	.11	6.00
November	61½	.09	5.53
December	61½	.09	5.53
Total	229½		\$23.54

LIVE POULTRY SOLD.

Two birds to Dr. VanEs for experimental purposes.....	\$0.50
Allowed to T. Hannon 3 pullets for use of setting hens....	3.00
One Single Combed Brown Leghorn Cockerel.....	1.50
Total	\$5.00

INVENTORY FOR JANUARY 1, 1906.

Kind of Bird.	Barred Plymouth Rocks.	Single Combed Brown Leghorns.	Rose Combed Leghorns.	Total.
Pullets	82	28	..	110
Hens	25	22	3	50
Cockerels	25	7	1	33
Cocks	1	..	..	1
Totals	133	57	4	194

Number of deaths during the year among the old stock..... 8

SUMMARY.

Eggs to Farmhouse.....	\$100.64
Six Settings of Eggs.....	6.00
Sale of Breeding Stock.....	5.00
Poultry for Farmhouse	23.54
Total	\$135.18

The prices quoted on undressed poultry and eggs were procured from Perry and Tyner, Commission Merchants of Fargo, N. D., and are the estimated averages for each month.

Two bulletins which are almost ready for the press contain the results of numerous other trials conducted during the past season.

ACKNOWLEDGMENTS.

I wish to hereby acknowledge the assistance which I have received in the preparation of this report and in carrying out the details of the trials described in the foregoing pages.

O. O. Churchill, Assistant in Plant Breeding, is accredited in the body of the report and hence his work requires no comment.

J. C. McDowell, Assistant Agriculturist of the Station, has had little time to devote to investigation, owing to the heavy pressure of the teaching duties assigned to him. He made some soil moisture studies which will be tabulated and the results presented in a future report.

W. B. Richards, Assistant Animal Husbandman, has carried out a considerable amount of successful experiment work which will be reported upon when more data has been gathered together.

Nicholaus Grest, foreman of the College farm, has relieved me by taking much of the responsibility which would ordinarily be carried by the Farm Superintendent. He had the chief responsibility in the planning and construction of the poultry house, yards and appliances, constructed during the year. Together with Oliver Dynes he has carried out the details of the work with the poultry belonging to the institution. He has also rendered me great service by his ingenuity and tireless efforts in planning and building the binder appliances described in another portion of this report.

Respectfully submitted,

J. H. SHEPPERD,
Agriculturist.

DEPARTMENT OF HORTICULTURE

To, Director J. H. Worst—

Sir: The work in the Horticultural Department for the year 1905 was a continuation of the work along the general lines of the previous year. Six thousand young forest trees were set at Fargo and an equal number at Dickinson. In addition to the varieties of trees already growing at the home station one hundred black walnut, one hundred catalpa, and five hundred hackberry were planted. Fifteen hundred Russian wild olive trees were also planted at Fargo, and five hundred at Dickinson. The other varieties planted in number were the white and green ash, soft maple, box elder, and American elm. Twenty-five red cedar trees, five feet in height, were brought from Medora and transplanted at Fargo.

The report on the condition of the trees planted at Dickinson will be found in the report of the Superintendent of that station. The season was unusually favorable for tree planting, and there was practically no loss among any of the trees planted at Fargo.

The plantations were made in connection with the series of experiments commenced two years ago to determine the best methods of planting groves and timber belts, both as regards the proper grouping of varieties and the general plan of planting and cultivation.

The first cost of getting a large number of experimental tree plots started has kept us from making any very extended experiments. Last year an arrangement was entered into with the Division of Forestry to the effect that such trees as are needed for experimental work will be furnished by them. The ground for this co-operative work has been selected and plowed, and in the spring five acres of trees will be planted using half-acre lots. Forty distinct plot experiments have been planned, the whole to cover twenty acres. It is planned to plant five acres each season till the planting is completed.

The plum and apple trees planted in 1905 nearly all made a satisfactory growth. The following apples bore fruit in 1905: Hiberna, Veteran, Berlin, Lyman's Prolific and Siberian Crab. The Hiberna bore a very full crop, as it also did the previous season.

Though growing in a poor apple location, the trees have proved entirely satisfactory, being thrifty, productive, and practically free from blight.

The Berlin comes into bearing later, but the fruit is better than the Hiberna while the tree grows into much better shape and seems quite as free from blight. During the Exoascus, or plum-pocket, but a small quantity of fruit was obtained from any of the varieties of plums. This disease is becoming more serious each year and already seriously threatens the possibility of plum growing. Owing to the fact that the disease is perennial, that is, lives in the young tissues of the tree from year to year, the ordinary methods of treating plant diseases are not available in this case. Neither is there any marked tendency for any of the trees to show immunity from the disease.

A search was made for wild plums more or less immune, but without results. The sand cherry growing upon our grounds last year was quite as badly affected as the plum, but the crosses between the sand cherry and wild plum were not affected. It is, of course, likely that these crosses may show the disease later. A number of plum blossoms were pollenized from these plum and cherry hybrids with the hope of obtaining plants having the immunity that the hybrids so far seem to have. As all of the fruit thus pollenized was afterward affected by the disease, no results were obtained. At present the prospect is not encouraging.

Strawberries, as usual, made a good showing except on plots too constantly covered with water. Fifty new varieties were set in the trial beds in the spring and these will be in bearing the coming season. The large bed set in October, 1904, on freshly plowed clover sod made as fine a growth of plants as we have ever seen. The plot comprises just one acre and was planted with the idea of conducting a strawberry experiment upon a commercial scale using a clover crop as a preparation of the soil and setting the plants in autumn. The yield for the coming season will determine how practical such a plan is. It has certain obvious advantages that can be discussed to a better purpose after the crop has been harvested.

VEGETABLE CULTURE.

The excessive rainfall of the past season practically eliminated all results with vegetables. A considerable number of variety tests and a few cultural tests were started in the spring, but owing to the continued saturation of the soil, the results, where any were obtained, were without value.

INJURIOUS INSECTS

A few trips were made to different portions of the state to observe what insects, if any, were injuring the crops. In the spring complaint of the ravages of the cut-worm came from nearly all parts of the state. In some places gardens were reported as wholly de-

stroyed, and flax and other field crops more or less damaged. Such preventative measures as we have found successful were recommended. With field crops, early fall plowing with subsequent cultivation, if necessary, to kill the weeds and volunteer grain, thus destroying the food supply of the summer hatched larvae, is about the only practical remedy. For gardens, covering the land with straw late in the summer and burning just before plowing in the spring has been found by us to be an absolute preventative. This prevents the moths from laying their eggs while the larvae, already in the ground, are either starved or destroyed by the burning of the straw.

Another insect reported in large numbers for the first time was the ear-worm, found in corn, for which there is no practical remedy. A description and life history of this insect was furnished to the press of the state. In looking up the Hessian fly, I visited wheat fields in Ransom, Richland, Cass, Grand Forks, Nelson, Ramsey, Towner, Pembina and Rolette Counties. The fly was found in all of the fields visited, being worst toward the north and west, where it has not previously been found in great numbers. In the northern tier of counties, the loss ranged from five to thirty or even fifty percent. Directions for controlling this pest were given at the different places visited and further instructions are to be sent out later.

C. B. WALDRON,
Horticulturist.

DEPARTMENT OF VETERINARY SCIENCE

President J. H. Worst, Director,

Agricultural College, North Dakota—

Sir: During the past year this department has been engaged in some work on the laboratory diagnosis of rabies. For some years the method first described by Nelis and Van Gehuchten has been quite generally employed for this purpose and brought about quite a saving in time as compared with the inoculation methods. A further improvement and greater saving in time has apparently been made possible by Prof. Negri, who found in the nerve cells of the ammon's horn of the cerebrum and in the Purkinje cells of the cerebellum of rabid animals acidophile, vacuolated bodies, which are claimed to be peculiar to the disease. Those bodies may be demonstrated within a day after the receipt of the head of the animal under suspicion and it need not be said, that, if further experience with the method should prove its reliability, a great advantage has been gained. The laboratory diagnosis of rabies is of an enormous importance in case we have to deal with cases in which people have been bitten by animals which are suspected of suffering from the disease. In such cases the time necessary for diagnosis is of prime importance, because the sooner a bitten person knows that the offending animal was really rabid, the sooner he will avail himself of the preventative treatment at a Pasteur Institute, and the better will be his chances of safeguarding himself against a most distressing and absolutely fatal disease.

When, therefore, the opportunity for using the new method presented itself, it was deemed wise to make use of it and to experiment with it with a view of gathering additional facts.

The material used for this purpose was obtained from brains of cattle, which died of rabies in Ward County, and those of rabbits used for biologic diagnosis of the Ward County cases, and those which were later on utilized for the propagation of the virus.

In the material from the bovine heads the Negri bodies were readily demonstrated by teasing the tissues after it had remained in Zenker's fluid for 24 hours, as well as in paraffine sections, stained with eosine and toluidine blue.

The rabbit tissues have, however, not yet been worked over, as, owing to the refitting of the laboratory all research work had to be suspended for the time being.

The gathering of material and its classification was, however, continued until a shortage in our laboratory animals made a temporary discontinuation of this work imperative.

The resumption of this line of work is, however, contemplated for the coming spring, while in addition some experiments are being planned to settle the point whether the Negri bodies are of a post mortem origin in rabies cases, or whether they are to be found during the incubation period. Besides, the department will engage in work, with a view of ascertaining the presence or non-presence in other diseases.

As nearly all of the material collected has yet to be worked over, a detailed description of the data, gathered thus far, will be deferred until a future time.

In addition to the work on rabies, some attention has been paid to a disease of the horse known as "swamp fever." This disease, which is at times very prevalent in certain regions of the Red River Valley, has been investigated by the livestock sanitary authorities of Manitoba and Minnesota. From various data obtained it may appear, however, that there is, perhaps, more than one disease embraced in the term swamp fever.

In order to gather some facts in regard to the disease mentioned, this department has for some time been on the lookout for some cases, but did not succeed in getting the donation of a horse alleged to be affected with this malady until early in the fall of 1905. This case was kept for clinical observation until a week ago, when the condition of the animal rendered its destruction necessary from a humane standpoint.

An autopsy, as careful as the circumstances permitted, was held. Tissues were collected for histologic examination, while from different organs and lesions, material was taken for bacteriologic examination with the result that several cultures of micro-organisms are now being studied.

The short time which has passed since the autopsy renders a full report on this case impossible, but the work will be reported in detail as soon as completed.

During the past year the laboratory facilities of the department have been considerably augmented. The room now in use for that purpose is of sufficient size, well lighted and conveniently equipped with fixtures. There also has been some necessary additions in apparatus, while a small room next to the laboratory has become available for the keeping of inoculated laboratory animals.

The most imperative need of this department at the present time is a suitable isolation stable, where experiments in animal diseases may be carried on without danger of spreading infection.

Data gathered during the past summer indicates that bovine tuberculosis is quite prevalent in some of our best herds, and in connection with the discoveries made by von Behring this department should undertake some experiments in order to see if the information coming from abroad contains anything of benefit and for the protection of our livestock industry. Such experiments, however, will be out of the question, without suitable stable facilities.

The same may be said in regard to experimental work on glanders, which should be undertaken in a state where the disease is so prevalent.

Respectfully submitted,

L. VAN ES.

STATEMENT

Of Receipts and Expenditures from July 1st, 1904 to July 1st, 1905.

RECEIPTS.

Received from U. S. Hatch, Acct. March 2, 1887...\$15,000.00

DISBURSEMENTS.

By salaries	\$7,339.05
Labor	2,964.38
Publications	1,102.74
Postage and Stationery	300.10
Freight and Express	.25
Heat, light, water and power.....	396.13
Chemical supplies	111.96
Seeds, plants and sundry supplies.....	670.14
Feeding stuffs	320.26
Library	111.22
Tools, implements and machinery.....	104.45
Furniture and fixtures	10.60
Scientific apparatus	247.44
Live Stock	515.00
Traveling expenses	128.04
Contingent expenses	24.00
Buildings and repairs	654.24
Total	\$15,000.00

C. E. NUGENT,
Secretary.

